CLAY MASONRY FAMILY FALLOUT SHELTERS

MP-18

February 1960

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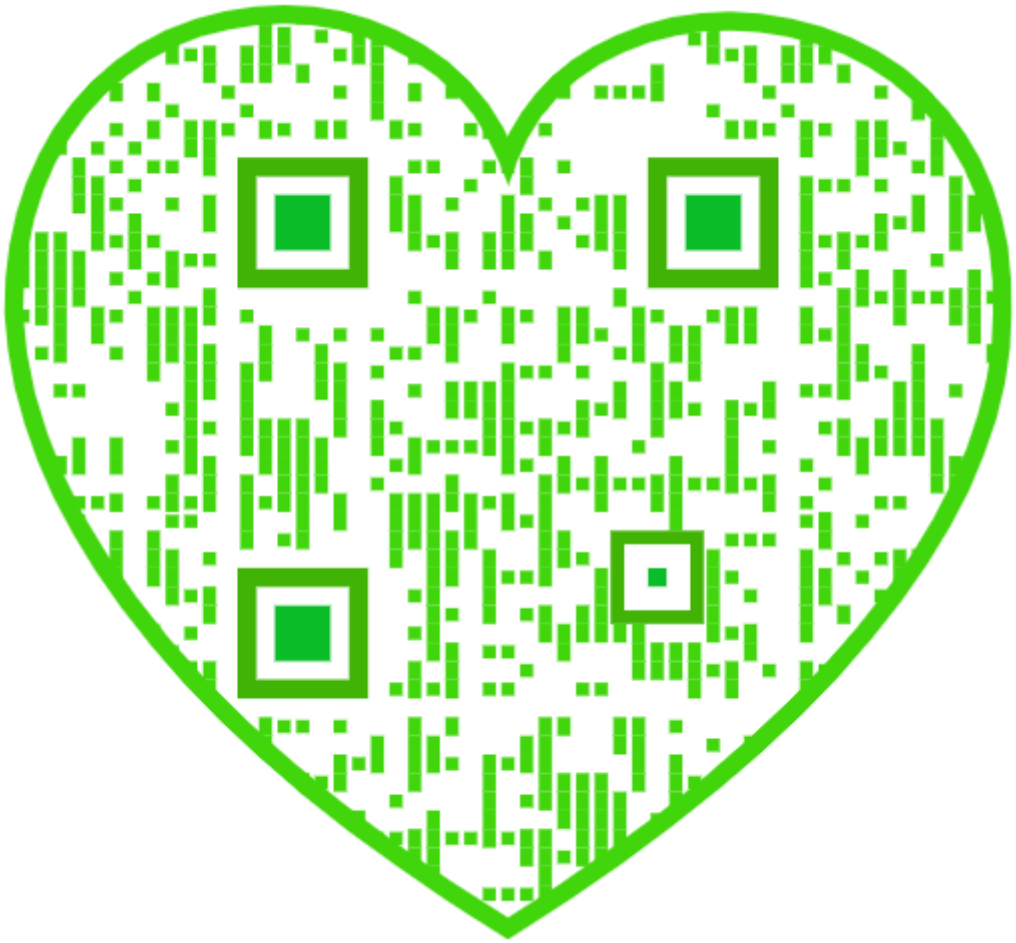

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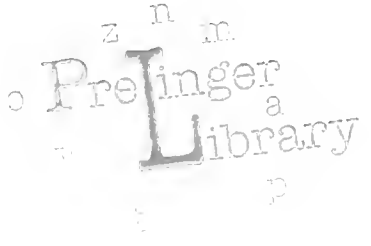

San Francisco, California
2008

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DEFINITIONS

Radioactive fallout is particles of earth and debris drawn up into the fireball and resulting mushroom shaped cloud of a nuclear explosion which become radioactively contaminated, and later fall back to earth.

Radioactivity is the emission of radiant energy, alpha, beta, and gamma rays, by the disintegration of the nuclei of atoms.

Shielding —There are two methods of shielding from fallout radiation: *barrier shielding* and *geometry shielding.*

Barrier shielding is the placing of a mass between the fallout field and the individual. The heavier the protective barrier, the greater the barrier shielding effect.[1]

Geometry shielding is determined by the extent of the fallout field affecting an individual, and/or his distance from it.[2]

Mass thickness is the weight per unit surface area of a barrier, usually expressed in pounds per square foot. See Table II, which indicates commercially available wall thicknesses for equivalent mass thicknesses of several materials.

Protection factor—The combined effects of barrier shielding and geometry shielding result in a shelter "protection factor". This term is used by technicians to express the relative reduction in the amount of radiation that would be received by a person in a protected location, compared to the amount he would receive if he were unprotected. For example if a shelter has a protection factor of 500, an unprotected person would be exposed to 500 times more radiation than someone inside the shelter.

Wythe—Each continuous vertical 4 inches or greater section of thickness of masonry.

Overpressure—For nuclear blast design, the first important decision that must be made is the level of blast pressure that is to be resisted by the structure. This pressure is spoken of as "overpressure", or the excess of pressure over normal atmospheric pressure due to the passage of the shock front.

Reflected pressure—When the blast wave strikes a surface, such as that of a structure, a reflected pressure results which can be more than twice the value of the peak overpressure.

[1]"Fallout Shelter Surveys: Guide for Executives," Office of Civil and Defense Mobilization, October 1959.

[2]Ibid.

INTRODUCTION

Radioactive fallout respects no person and no place. There is not a home in America that could not be affected by fallout after a nuclear attack. Shelter from fallout is the greatest single protection for you and your family.

The Office of Civil and Defense Mobilization published last year "The Family Fallout Shelter" booklet MP 15. That publication contains plans for five basic fallout shelters.

The Structural Clay Products Institute of Washington, D. C., has prepared the booklet "Clay Masonry Family Fallout Shelters" in order to provide the public with five additional plans for basic fallout shelters which can be built in or near your home. OCDM technical officers have reviewed and found that it meets OCDM standards for effective shelter.

Each of these shelters provides protection from fallout radiation of a nuclear bomb. They also can protect your family against natural disasters such as hurricanes and tornadoes.

This booklet demonstrates again that there ***are*** means of protection against fallout—if you do something about it before disaster strikes.

LEO A. HOEGH
Director
Office of Civil and Defense Mobilization

UNDERGROUND SHELTER

An underground clay masonry fallout shelter can be built by a contractor for about $800 to $1,200, depending upon the entrance used. Figure 7 is the line drawing for this shelter. The shelter will provide excellent fallout protection. It has a protection factor of 1,000 or more on the basis of OCDM criteria.

The line drawing (fig. 7) shows the shelter with earth mounded over the roof. This shelter can be built into an embankment or entirely below grade.

This shelter also provides excellent protection against hurricanes and tornadoes, and can easily be made blast resistant by providing a blast-resistant door at the entrance. It already has some inherent blast resistance (approximately 5 - 7 psi blast overpressure). It may be necessary, however, to provide greater stability depending upon the design overpressure. If a blast shelter is desired, it is recommended that a competent engineer be employed.

ABOVEGROUND SHELTER

An outdoor aboveground fallout shelter can be built of clay masonry units. Most generally this type of shelter is built in regions where water or rock is close to the earth's surface making it impractical to build underground.

The exterior walls of this shelter are constructed of two wythes of brick, 1-foot, 8-inches apart. The space between the brick is filled with compacted pit-run sand or gravel. The two brick wythes are tied together with non-corrosive metal ties as indicated on the line drawing shown as figure 8.

The roof is a 6-inch reinforced concrete slab, having a brick parapet wall. Upon this slab is placed two coats of hot asphalt waterproofing, then 16 to 20 inches of pit-run sand or gravel fill.

This shelter will provide exceptionally good protection against fallout at a cost of about $900 to $1,250. This shelter has a protection factor of 250 to 1,000, based on OCDM criteria.

BLAST AND FALLOUT SHELTER ABOVEGROUND

Reinforced Brick Masonry (RBM) is employed in making the family shelter shown as figure 9 resistant to blast as well as fallout. This aboveground shelter provides excellent protection against the ravages of hurricanes and tornadoes in addition to its radiation shielding. Most generally this type of shelter is built in regions where water or rock is close to the earth's surface, making it impractical to build underground.

A family in this shelter would be protected from a nuclear explosion of 20-megaton size as close as 5 miles from ground zero. The radiation protection factor of this shelter is approximately 600 - 700, based on OCDM criteria.

The exterior walls of the shelter are constructed of two walls of brick masonry, 1 foot apart. One wall is a 10-inch RBM wall and the other is 4 inches of brick tied to the RBM wall with non-corrosive metal ties spaced as indicated on the drawing (fig. 9). The space between the brick is filled with compacted pit-run sand or gravel.

The roof is a 10-inch slab of reinforced concrete upon which is poured 10 more inches of fill concrete, making a total roof thickness of 20 inches. The door is blast resistant and heat reflective, able to withstand a blast overpressure of approximately 10 pounds per square inch.

Blast and fallout protection is provided by this shelter at a cost of approximately $1,200 to $1,700 dollars.

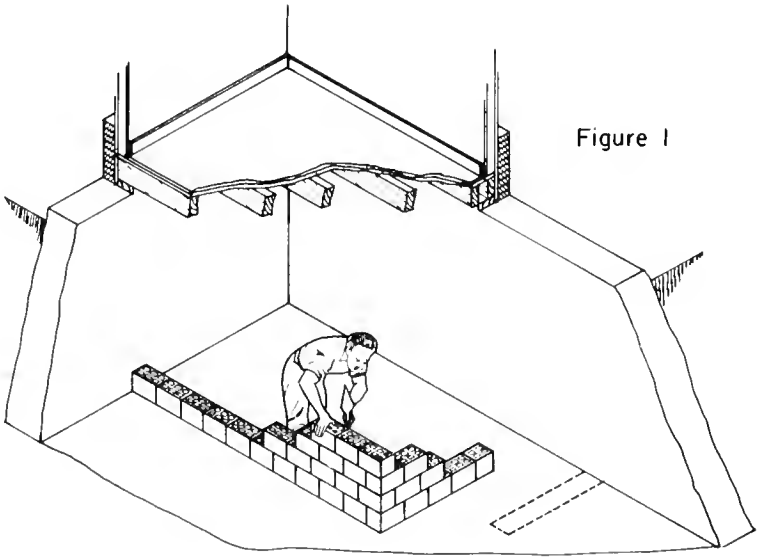

Figure 1

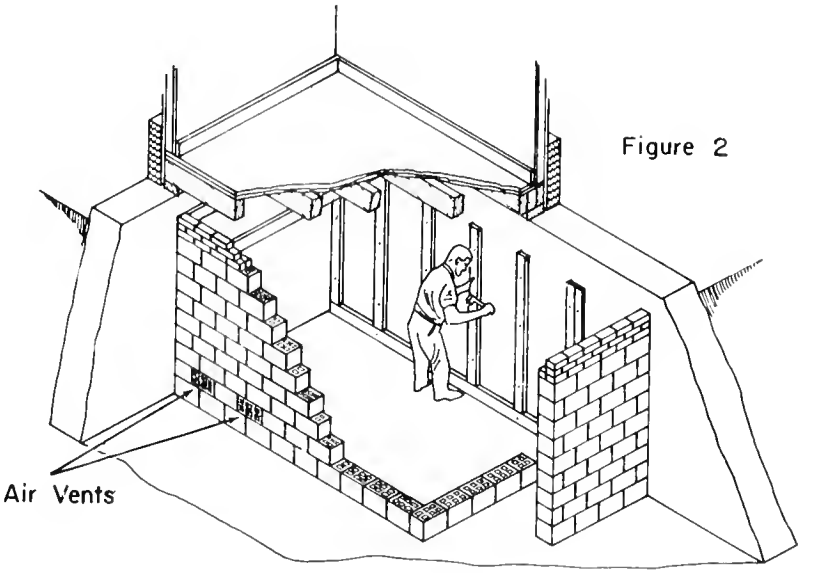

Figure 2

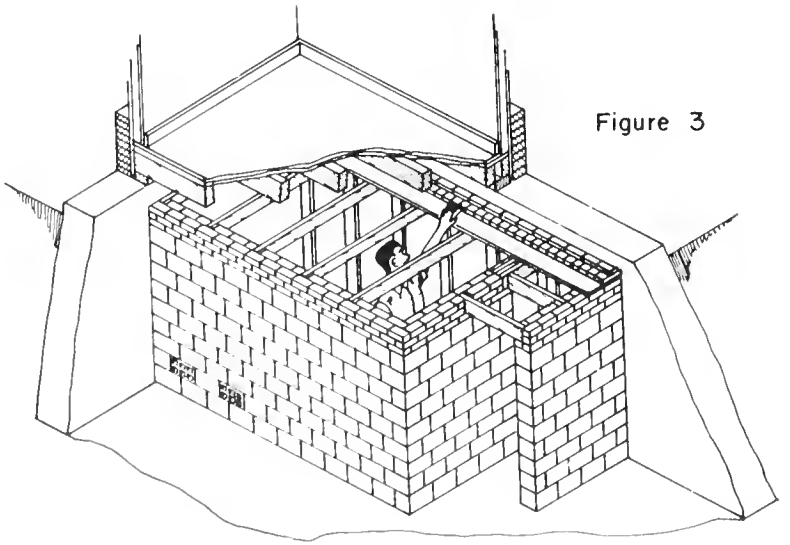

Figure 3

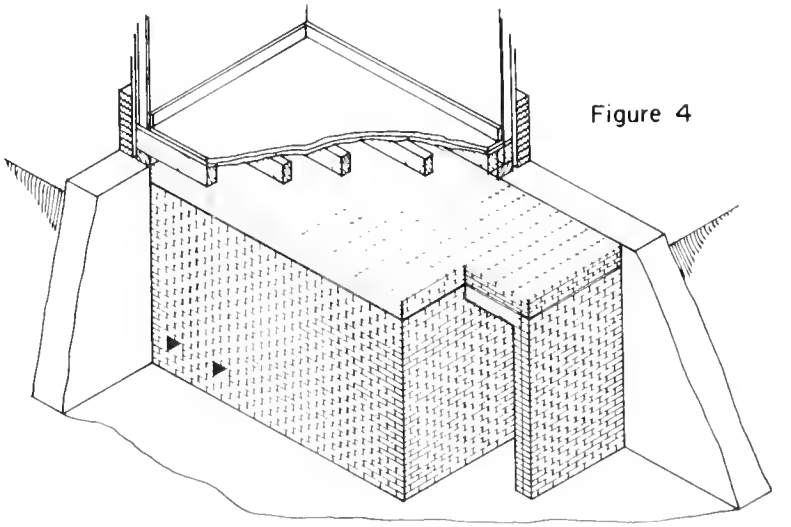

Figure 4

APPENDIX

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Note: Larger scale drawings of figures 5, 6, 7, 8, and 9 may be obtained through your local civil defense organization, or from OCDM, Battle Creek, Michigan. It is important that drawings be ordered by "Figure Number" and that reference be made to this publication, MP–18.

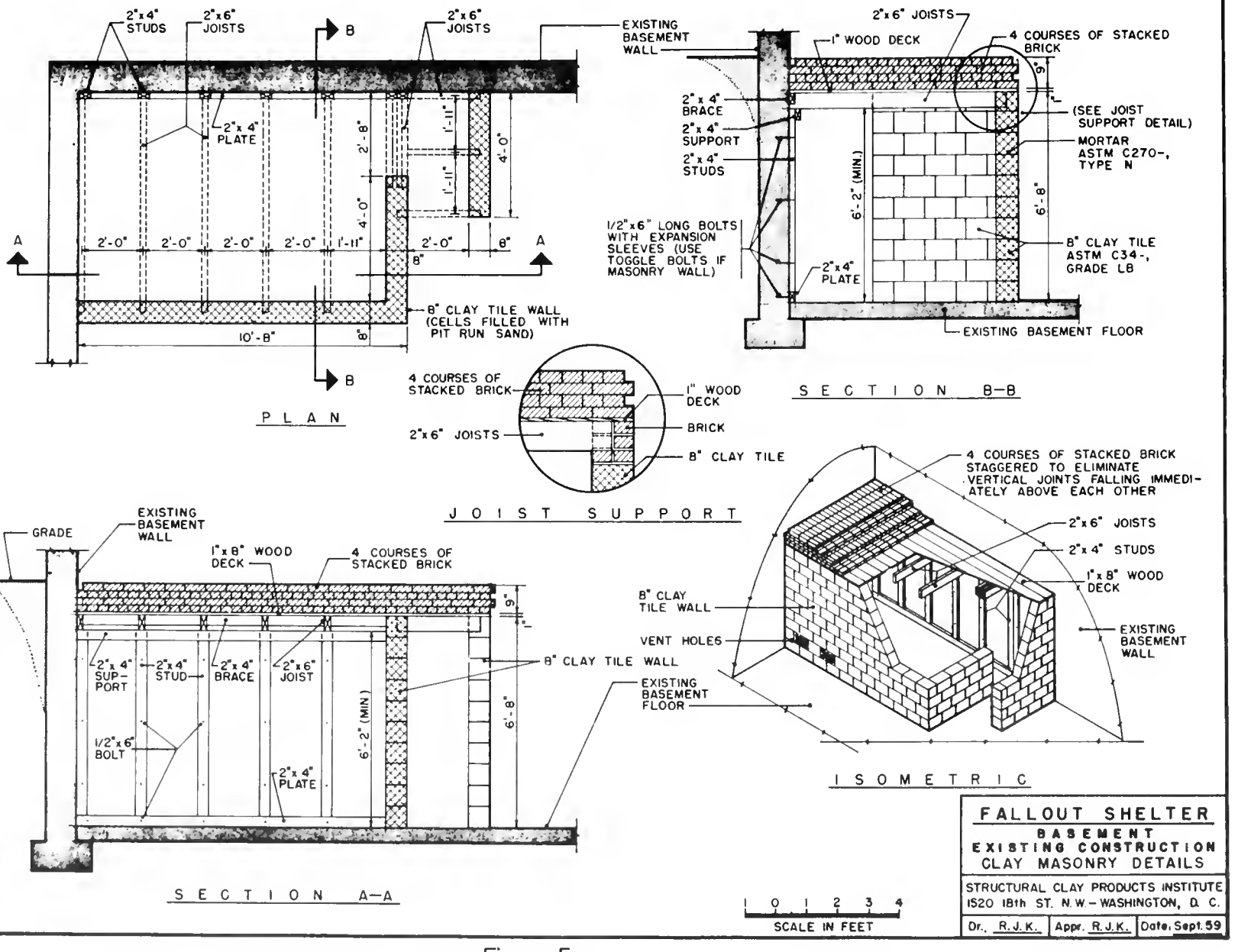
2"x4" STUDS
2"x6" JOISTS
B
2"x6" JOISTS
EXISTING BASEMENT WALL
2"x4" PLATE
2'-8"
1'-11"
1'-11"
4'-0"
4'-0"
A
2'-0"
2'-0"
2'-0"
2'-0"
1'-11"
2'-0"
8"
8"
A
8" CLAY TILE WALL (CELLS FILLED WITH PIT RUN SAND)
10'-8"
8"
B
PLAN
2"x6" JOISTS
1" WOOD DECK
4 COURSES OF STACKED BRICK
9"
1"
(SEE JOIST SUPPORT DETAIL)
2"x4" BRACE
2"x4" SUPPORT
2"x4" STUDS
MORTAR ASTM C270-, TYPE N
6'-2" (MIN.)
6'-8"
1/2"x6" LONG BOLTS WITH EXPANSION SLEEVES (USE TOGGLE BOLTS IF MASONRY WALL)
8" CLAY TILE ASTM C34-, GRADE LB
2"x4" PLATE
EXISTING BASEMENT FLOOR
SECTION B-B
4 COURSES OF STACKED BRICK
1" WOOD DECK
2"x6" JOISTS
BRICK
8" CLAY TILE
JOIST SUPPORT
4 COURSES OF STACKED BRICK STAGGERED TO ELIMINATE VERTICAL JOINTS FALLING IMMEDIATELY ABOVE EACH OTHER
2"x6" JOISTS
2"x4" STUDS
1"x8" WOOD DECK
8" CLAY TILE WALL
VENT HOLES
EXISTING BASEMENT FLOOR
EXISTING BASEMENT WALL
ISOMETRIC
GRADE
EXISTING BASEMENT WALL
1"x8" WOOD DECK
4 COURSES OF STACKED BRICK
9"
1"
2"x4" SUP-PORT
2"x4" STUD
2"x4" BRACE
2"x6" JOIST
8" CLAY TILE WALL
6'-2" (MIN.)
6'-8"
1/2"x6" BOLT
2"x4" PLATE
SECTION A-A
0 1 2 3 4
SCALE IN FEET
FALLOUT SHELTER
BASEMENT
EXISTING CONSTRUCTION
CLAY MASONRY DETAILS
STRUCTURAL CLAY PRODUCTS INSTITUTE
1520 18th ST. N.W. - WASHINGTON, D. C.
Dr. R.J.K.
Appr. R.J.K.
Date. Sept. 59

Figure 5

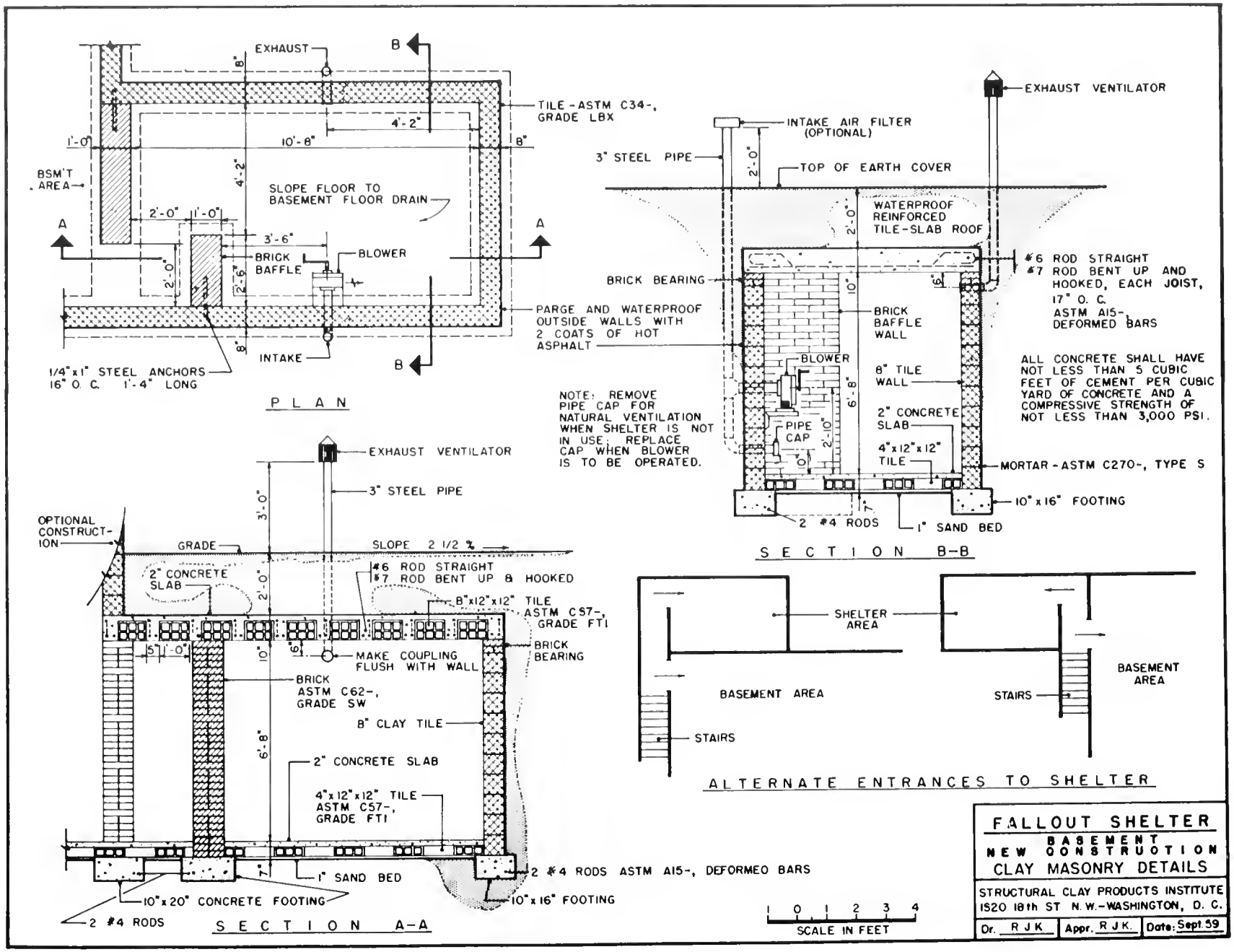
EXHAUST
B
TILE - ASTM C34-, GRADE LBX
4'-2"
10'-8"
8"
1'-0"
BSM'T AREA
SLOPE FLOOR TO BASEMENT FLOOR DRAIN
A
2'-0"
1'-0"
3'-6"
BRICK BAFFLE
BLOWER
2'-0"
2'-6"
PARGE AND WATERPROOF OUTSIDE WALLS WITH 2 COATS OF HOT ASPHALT
INTAKE
1/4"x1" STEEL ANCHORS 16" O. C. 1'-4" LONG
PLAN
EXHAUST VENTILATOR
INTAKE AIR FILTER (OPTIONAL)
3" STEEL PIPE
TOP OF EARTH COVER
WATERPROOF REINFORCED TILE-SLAB ROOF
#6 ROD STRAIGHT #7 ROD BENT UP AND HOOKED, EACH JOIST, 17" O. C. ASTM A15- DEFORMED BARS
BRICK BEARING
BRICK BAFFLE WALL
BLOWER
8" TILE WALL
2" CONCRETE SLAB
PIPE CAP
4"x12"x12" TILE
MORTAR - ASTM C270-, TYPE S
10"x16" FOOTING
2 #4 RODS
1" SAND BED
NOTE: REMOVE PIPE CAP FOR NATURAL VENTILATION WHEN SHELTER IS NOT IN USE; REPLACE CAP WHEN BLOWER IS TO BE OPERATED.
ALL CONCRETE SHALL HAVE NOT LESS THAN 5 CUBIC FEET OF CEMENT PER CUBIC YARD OF CONCRETE AND A COMPRESSIVE STRENGTH OF NOT LESS THAN 3,000 PSI.
SECTION B-B
EXHAUST VENTILATOR
3" STEEL PIPE
OPTIONAL CONSTRUCTION
GRADE
SLOPE 2 1/2 %
2" CONCRETE SLAB
#6 ROD STRAIGHT #7 ROD BENT UP & HOOKED
8"x12"x12" TILE ASTM C57-, GRADE FTI
BRICK BEARING
MAKE COUPLING FLUSH WITH WALL
BRICK ASTM C62-, GRADE SW
8" CLAY TILE
2" CONCRETE SLAB
4"x12"x12" TILE ASTM C57-, GRADE FTI
1" SAND BED
2 #4 RODS ASTM A15-, DEFORMED BARS
10"x20" CONCRETE FOOTING
10"x16" FOOTING
2 #4 RODS
SECTION A-A
SHELTER AREA
BASEMENT AREA
STAIRS
BASEMENT AREA
STAIRS
ALTERNATE ENTRANCES TO SHELTER
0 1 2 3 4
SCALE IN FEET
FALLOUT SHELTER
BASEMENT NEW CONSTRUCTION
CLAY MASONRY DETAILS
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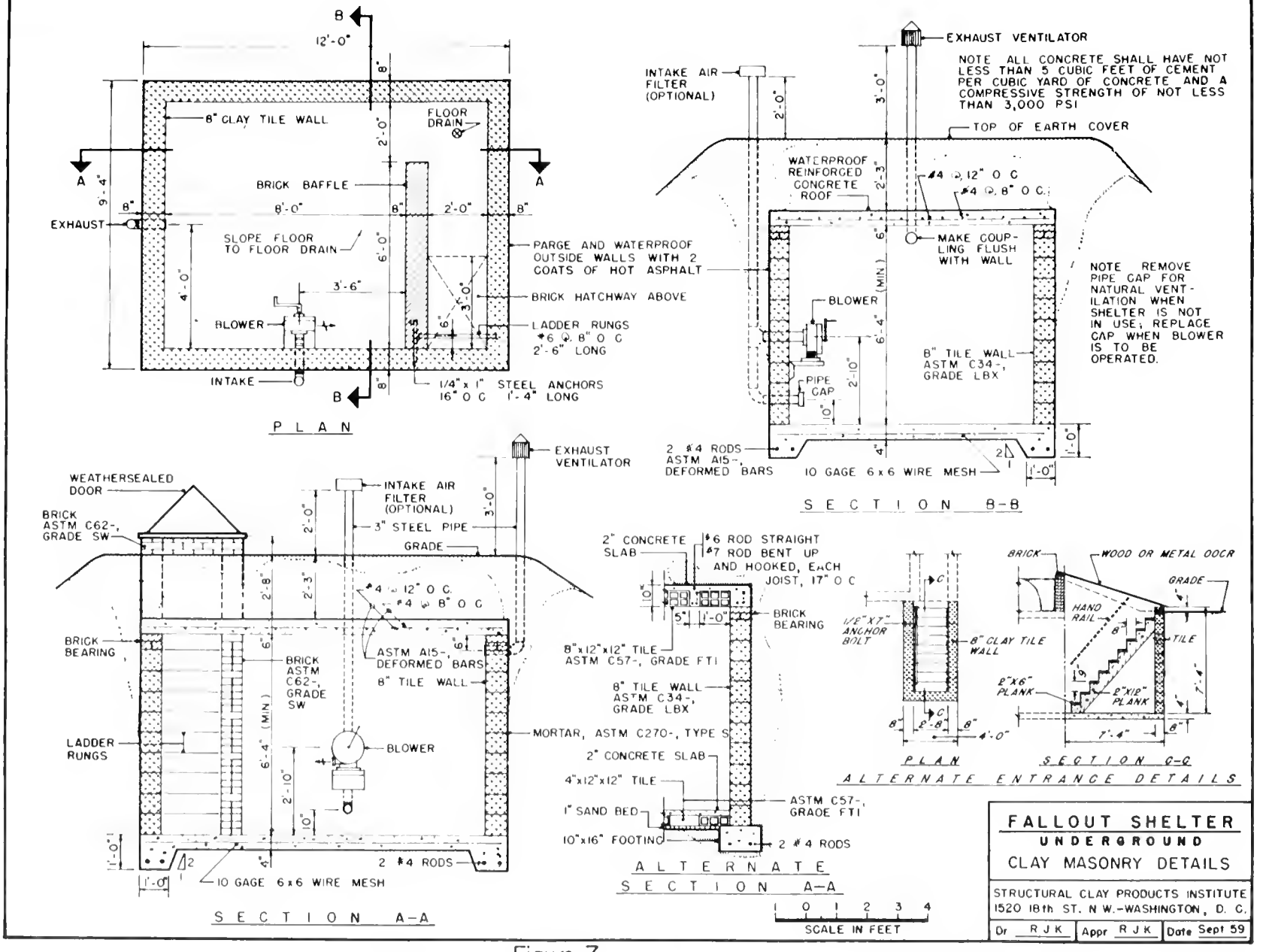
Figure 6


B
12'-0"
8" CLAY TILE WALL
FLOOR DRAIN
BRICK BAFFLE
8'-0"
2'-0"
EXHAUST
SLOPE FLOOR TO FLOOR DRAIN
PARGE AND WATERPROOF OUTSIDE WALLS WITH 2 COATS OF HOT ASPHALT
BRICK HATCHWAY ABOVE
LADDER RUNGS #6 @ 8" O C 2'-6" LONG
BLOWER
3'-6"
INTAKE
1/4" x 1" STEEL ANCHORS 16" O C 1'-4" LONG
PLAN
EXHAUST VENTILATOR
INTAKE AIR FILTER (OPTIONAL)
NOTE ALL CONCRETE SHALL HAVE NOT LESS THAN 5 CUBIC FEET OF CEMENT PER CUBIC YARD OF CONCRETE AND A COMPRESSIVE STRENGTH OF NOT LESS THAN 3,000 PSI
TOP OF EARTH COVER
WATERPROOF REINFORCED CONCRETE ROOF
#4 @ 12" O C
#4 @ 8" O C
MAKE COUPLING FLUSH WITH WALL
NOTE REMOVE PIPE CAP FOR NATURAL VENTILATION WHEN SHELTER IS NOT IN USE; REPLACE CAP WHEN BLOWER IS TO BE OPERATED.
BLOWER
PIPE CAP
8" TILE WALL ASTM C34-, GRADE LBX
2 #4 RODS ASTM A15-, DEFORMED BARS
10 GAGE 6x6 WIRE MESH
SECTION B-B
WEATHERSEALED DOOR
BRICK ASTM C62-, GRADE SW
INTAKE AIR FILTER (OPTIONAL)
3" STEEL PIPE
GRADE
#4 @ 12" O C
#4 @ 8" O C
BRICK BEARING
BRICK ASTM C62-, GRADE SW
ASTM A15-, DEFORMED BARS
8" TILE WALL
LADDER RUNGS
BLOWER
MORTAR, ASTM C270-, TYPE S
2 #4 RODS
10 GAGE 6x6 WIRE MESH
SECTION A-A
2" CONCRETE SLAB
#6 ROD STRAIGHT
#7 ROD BENT UP AND HOOKED, EACH JOIST, 17" O C
BRICK BEARING
8"x12"x12" TILE ASTM C57-, GRADE FTI
8" TILE WALL ASTM C34-, GRADE LBX
2" CONCRETE SLAB
4"x12"x12" TILE
1" SAND BED
10"x16" FOOTING
ASTM C57-, GRADE FTI
2 #4 RODS
ALTERNATE SECTION A-A
1/2" X 1" ANCHOR BOLT
8" CLAY TILE WALL
BRICK
WOOD OR METAL DOOR
GRADE
HAND RAIL
TILE
2"X6" PLANK
2"X12" PLANK
PLAN
SECTION C-C
ALTERNATE ENTRANCE DETAILS
0 1 2 3 4
SCALE IN FEET
FALLOUT SHELTER
UNDERGROUND
CLAY MASONRY DETAILS
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Appr RJK
Date Sept 59

Figure 7

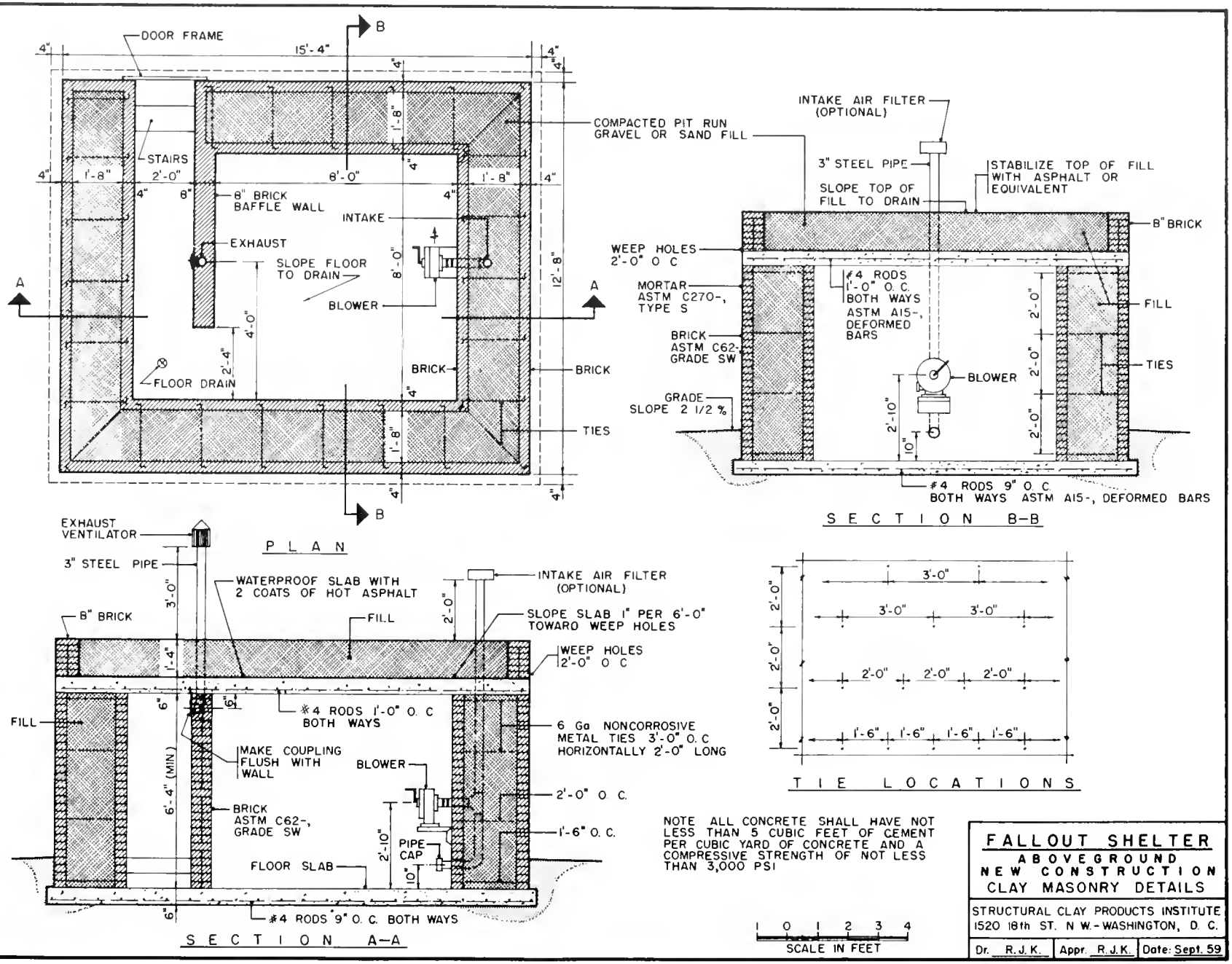
DOOR FRAME
15'-4"
STAIRS
2'-0"
8" BRICK
BAFFLE WALL
INTAKE
EXHAUST
SLOPE FLOOR
TO DRAIN
BLOWER
FLOOR DRAIN
BRICK
TIES
8'-0"
12'-8"
4'-0"
2'-4"
1'-8"
P L A N
INTAKE AIR FILTER
(OPTIONAL)
COMPACTED PIT RUN
GRAVEL OR SAND FILL
3" STEEL PIPE
SLOPE TOP OF
FILL TO DRAIN
STABILIZE TOP OF FILL
WITH ASPHALT OR
EQUIVALENT
8" BRICK
WEEP HOLES
2'-0" O C
MORTAR
ASTM C270-,
TYPE S
BRICK
ASTM C62-
GRADE SW
GRADE
SLOPE 2 1/2 %
#4 RODS
1'-0" O. C.
BOTH WAYS
ASTM A15-,
DEFORMED
BARS
FILL
TIES
BLOWER
2'-10"
10"
#4 RODS 9" O C
BOTH WAYS ASTM A15-, DEFORMED BARS
S E C T I O N B–B
EXHAUST
VENTILATOR
3" STEEL PIPE
WATERPROOF SLAB WITH
2 COATS OF HOT ASPHALT
INTAKE AIR FILTER
(OPTIONAL)
SLOPE SLAB 1" PER 6'-0"
TOWARD WEEP HOLES
8" BRICK
FILL
WEEP HOLES
2'-0" O C
#4 RODS 1'-0" O. C
BOTH WAYS
6 Ga NONCORROSIVE
METAL TIES 3'-0" O. C
HORIZONTALLY 2'-0" LONG
MAKE COUPLING
FLUSH WITH
WALL
BLOWER
BRICK
ASTM C62-,
GRADE SW
2'-0" O. C.
1'-6" O. C.
PIPE
CAP
FLOOR SLAB
#4 RODS 9" O. C. BOTH WAYS
3'-0"
1'-4"
6"
6'-4" (MIN.)
2'-10"
10"
S E C T I O N A–A
3'-0"
2'-0"
1'-6"
T I E L O C A T I O N S
NOTE ALL CONCRETE SHALL HAVE NOT
LESS THAN 5 CUBIC FEET OF CEMENT
PER CUBIC YARD OF CONCRETE AND A
COMPRESSIVE STRENGTH OF NOT LESS
THAN 3,000 PSI
0 1 2 3 4
SCALE IN FEET
FALLOUT SHELTER
ABOVEGROUND
NEW CONSTRUCTION
CLAY MASONRY DETAILS
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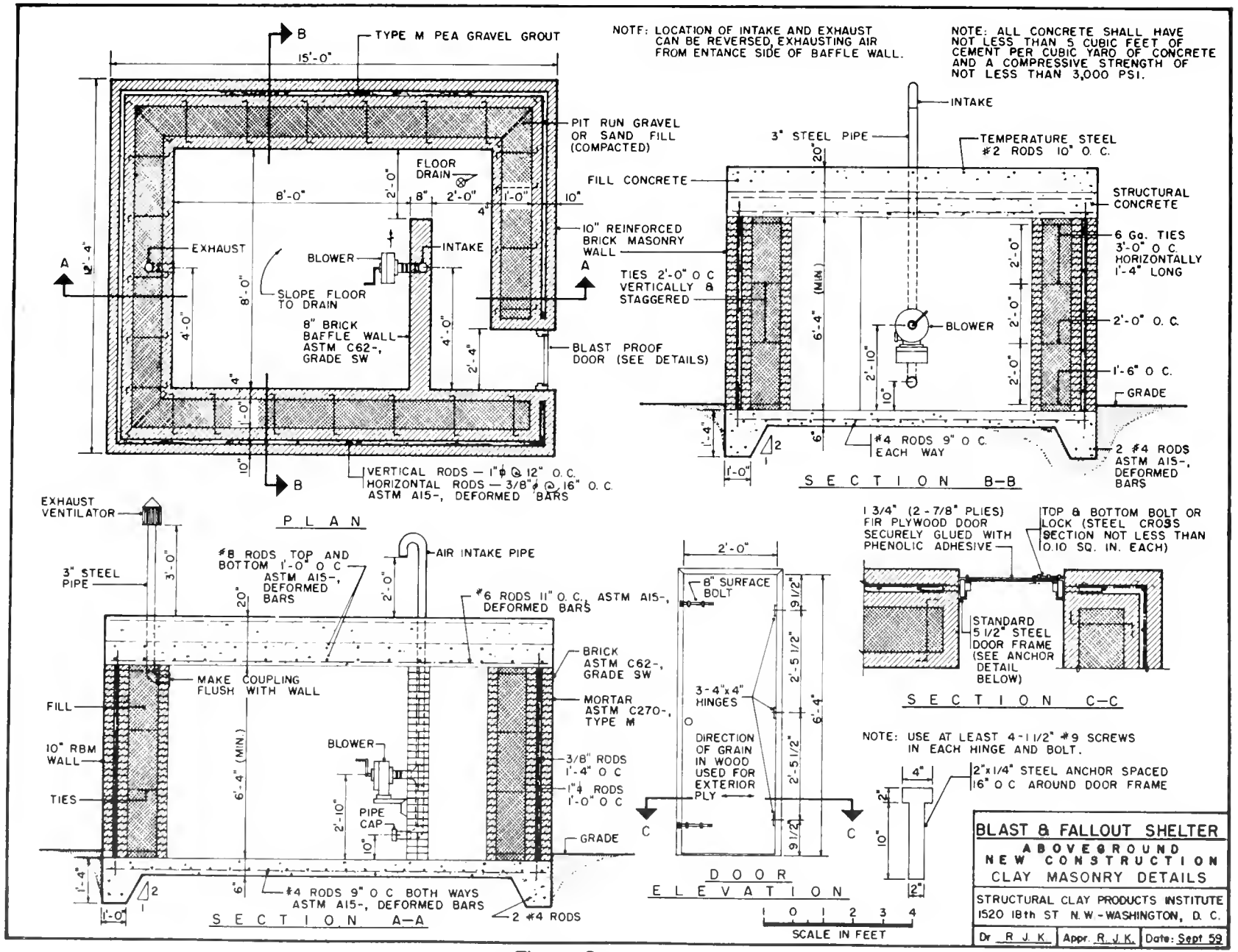
Figure 8


NOTE: LOCATION OF INTAKE AND EXHAUST CAN BE REVERSED, EXHAUSTING AIR FROM ENTANCE SIDE OF BAFFLE WALL.
NOTE: ALL CONCRETE SHALL HAVE NOT LESS THAN 5 CUBIC FEET OF CEMENT PER CUBIC YARD OF CONCRETE AND A COMPRESSIVE STRENGTH OF NOT LESS THAN 3,000 PSI.
TYPE M PEA GRAVEL GROUT
PIT RUN GRAVEL OR SAND FILL (COMPACTED)
FLOOR DRAIN
EXHAUST
BLOWER
INTAKE
SLOPE FLOOR TO DRAIN
8" BRICK BAFFLE WALL ASTM C62-, GRADE SW
10" REINFORCED BRICK MASONRY WALL
TIES 2'-0" O C VERTICALLY & STAGGERED
BLAST PROOF DOOR (SEE DETAILS)
VERTICAL RODS — 1"ϕ @ 12" O. C.
HORIZONTAL RODS — 3/8"ϕ @ 16" O. C.
ASTM A15-, DEFORMED BARS
PLAN
SECTION B-B
INTAKE
3" STEEL PIPE
TEMPERATURE STEEL #2 RODS 10" O. C.
FILL CONCRETE
STRUCTURAL CONCRETE
6 Ga. TIES 3'-0" O C. HORIZONTALLY 1'-4" LONG
2'-0" O. C.
1'-6" O C.
GRADE
#4 RODS 9" O C. EACH WAY
2 #4 RODS ASTM A15-, DEFORMED BARS
EXHAUST VENTILATOR
3" STEEL PIPE
#8 RODS TOP AND BOTTOM 1'-0" O C ASTM A15-, DEFORMED BARS
AIR INTAKE PIPE
#6 RODS 11" O. C., ASTM A15-, DEFORMED BARS
BRICK ASTM C62-, GRADE SW
MORTAR ASTM C270-, TYPE M
MAKE COUPLING FLUSH WITH WALL
FILL
10" RBM WALL
TIES
BLOWER
3/8" RODS 1'-4" O C
1"ϕ RODS 1'-0" O C
PIPE CAP
GRADE
#4 RODS 9" O C BOTH WAYS ASTM A15-, DEFORMED BARS
2 #4 RODS
SECTION A-A
8" SURFACE BOLT
3-4"x4" HINGES
DIRECTION OF GRAIN IN WOOD USED FOR EXTERIOR PLY
DOOR ELEVATION
SCALE IN FEET
1 3/4" (2 - 7/8" PLIES) FIR PLYWOOD DOOR SECURELY GLUED WITH PHENOLIC ADHESIVE
TOP & BOTTOM BOLT OR LOCK (STEEL CROSS SECTION NOT LESS THAN 0.10 SQ. IN. EACH)
STANDARD 5 1/2" STEEL DOOR FRAME (SEE ANCHOR DETAIL BELOW)
SECTION C-C
NOTE: USE AT LEAST 4 - 1 1/2" #9 SCREWS IN EACH HINGE AND BOLT.
2"x1/4" STEEL ANCHOR SPACED 16" O C AROUND DOOR FRAME
BLAST & FALLOUT SHELTER
ABOVEGROUND
NEW CONSTRUCTION
CLAY MASONRY DETAILS
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Dr R J K. Appr. R. J. K. Date: Sept 59

Figure 9

TABLE I.—Radiation Protection Factors

(For Small Aboveground Shelters)

Wall Mass Thickness, psf	Roof Mass Thickness, psf					
	100	150	200	250	300	400
100	12	15	15	15	15	15
150	25	40	45	50	50	50
200	40	85	115	140	145	150
250	50	130	230	335	385	415
300	55	160	345	670	910	1110
400	55	165	500	1670	5000	Greater than 5000

TABLE II.—Equivalent Mass Thicknesses (lb./sq. ft.)

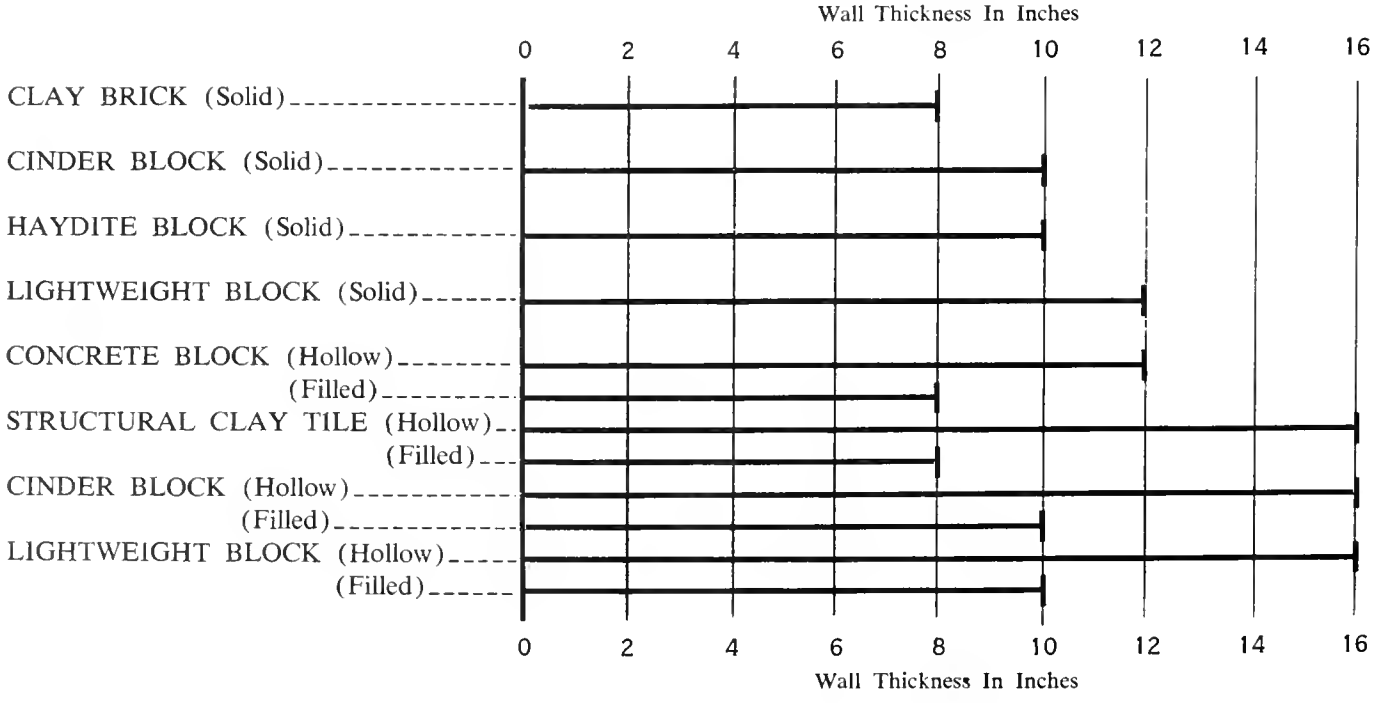

TABLE III.—Relation of Overpressure to Distances From Ground Zero*

(For a Typical Surface Blast)

Overpressure (psi)	Distance From Ground Zero	
	20 kilotons (atomic)	20 megatons (hydrogen)
40	1,500 ft. or 0.38 mi.	15,000 ft. or 2.8 mi.
20	1,900 ft. or 0.36 mi.	19,000 ft. or 3.6 mi.
10	2,700 ft. or 0.51 mi.	27,000 ft. or 5.1 mi.
5	4,000 ft. or 0.76 mi.	40,000 ft. or 7.6 mi.
2	8,000 ft. or 1.52 mi.	80,000 ft. or 15.2 mi.

* "The Effects of Nuclear Weapons"—U. S. Dept. of Defense, 1957 Fig. 3.94a, page 109.

TABLE IV.—Description of Shelter Protection Categories*

Protection factor	Shelter examples
1,000 or greater.	OCDM underground shelters. Subbasements of multistory buildings. Underground installations (mines, tunnels, etc.)
250 to 1,000.	OCDM basement fallout shelters (heavy masonry residences). Basements (without exposed walls) of multistory buildings.
50 to 250.	OCDM basement fallout shelters (frame and brick veneer residences). Central areas of basements (with partially exposed walls) of multistory buildings. Central areas of upper floors (excluding top floor) of large multistory buildings with heavy exterior walls and floors.
10 to 50.	Basements (without exposed walls) of small 1- or 2-story buildings. Central areas of upper floors (excluding top floor) of large multistory buildings with light exterior walls and floors.
2 to 10.	Basements (partially exposed) of small 1- or 2-story buildings. Central areas on ground floors in 1- or 2-story buildings with heavy masonry walls.
Less than 2.	Aboveground areas of low buildings, in general, including residences, stores, light industrial buildings.

* Based on current OCDM criteria.

TABLE V.—Tools Required for Building Basement Shelter, Existing Construction. (See fig. 5.)

ITEM	CHECK
Mixing pan for mortar	
Measuring pail for sand and cement	
Hoe for mixing mortar	
Hose or water can	
Mason's trowel (8″ or 10″)	
Mortar board	
Mason's level	
Mason's hammer	
Folding rule (6 ft.)	
Stringline and line blocks	
Chalkline, pencil	
Crosscut saw	
Claw hammer	
Carpenter's square	
Wrench (crescent)	
Drill, masonry bit, 5/8″, 5″ long wood bit, 5/8″, 4″ long	

TABLE VI.—Materials Required for Building Basement Shelter, Existing Construction. (See fig. 5.)

ITEM	AMOUNT
2-2/3″ x 4″ x 8″ brick	2250
8″ x 8″ x 12″ structural clay tile	205
2″ x 6″ structural grade lumber	35 lineal ft.
2″ x 4″ structural grade lumber	87 lineal ft.
1″ x 8″ (or 1″ x 12″) wood sheathing	88 board ft.
1/2″ x 6″ steel bolts	30
16 d nails, 8 d nails	1 lb. each
sand	60 cu. ft.
cement	2 cu. ft.
lime (or lime putty)	2 cu. ft.

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